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A Raft for Direct Subsurface Observation at Sea

By Reginald M. Gooding

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A Raft for Direct Subsurface Observation at Sea

By

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ABSTRACT

A raft with an underwater observation chamber was constructed to allow close study of the accumulations of fishes around a floating object at sea. A mother vessel carries the raft to the observation site and sets it adrift. The observation chamber accommodates one observer, who has a 360° view of the surrounding water. New information on fish behavior and ecology was gathered during several short drifts near the island of Hawaii and two drifts of 8 and 9 days in the equatorial Pacific.

INTRODUCTION

In 1962 a raft with an underwater observation chamber was built at the U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries Biological Laboratory in Honolulu to be used to observe ecological and behavioral interactions among fishes which are attracted by drifting objects on the open ocean.

Pelagic fishes frequently are seen in the vicinity of drifting material at sea, and at least three commercial seine fisheries and a pole-and-line fishery take advantage of fish accumulations around anchored floats. Dolphin, Coryphaena hippurus Linnaeus, are netted around anchored bamboo rafts in the Sea of Japan (Kojima, 1956) and around large slabs of cork anchored in the Mediterranean near Malta (Galea, 1961); mackerel scad, Decapterus sp., are caught around anchored coconut fronds in the Java Sea (Soemarto, 1960; Natadisastra, 1952; Westenberg, 1953). In the Japanese pole-and-line fishery, large catches of skipjack tuna, Katsuwonus pelamis (Linnaeus), yellowfin tuna, Thunnus albacares (Bonnaterre), and bigeye tuna, Thunnus obesus Lowe, are made near drifting material during certain seasons (Inoue, Amano, and Iwasaki, 1963; Kimura, 1954; Yabe and Mori, 1950).

Prior to the construction of the raft, several techniques for observing tuna underwater at sea from the research vessel Charles H. Gilbert were developed at the Bureau's Laboratory in Honolulu. This work culminated with the construction of an observation "blister" in the bow of the Gilbert (Strasburg and Yuen, 1960). Although fishes near floating logs have been seen from the underwater windows, the presence of the vessel so modifies the environment that serious study has not been practical. Since the raft Nenue [1/] (fig. 1) served as both the observation platform and the drifting object, it permitted study under conditions as natural as possible.

DESIGN

The Nenue consists of three units: a wooden raft buoyed with steel drums, a cylindrical steel observation chamber, and a small deckhouse (fig. 2).

1/ Nenue is the Hawaiian name for a reef fish, Kyphosus cinerascens, which is common under floating objects during its juvenile stage.

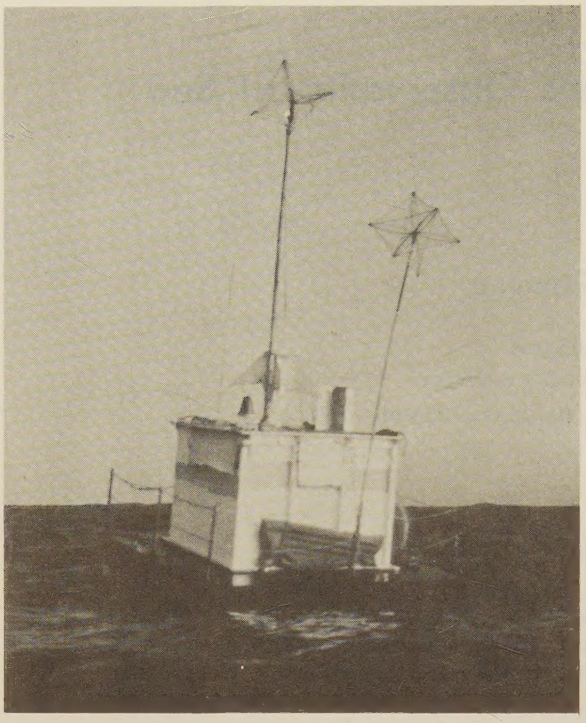


Figure 1.--Nenue adrift in the equatorial Pacific.

The 12-foot-square raft is strongly built to withstand rough handling at sea. The frame is constructed of 4- by 14-inch and 4- by 4-inch timbers lap-jointed and through-fastened with 5/8- by 15-inch galvanized steel bolts. Four 5/8-inch steel tie-rods further stiffen the structure. This frame is decked with 2- by 12-inch planks fastened with galvanized nails. Ten 55-gallon drums beneath the deck provide buoyancy[2/]. They are held in position between the tie-rods and the side timbers by rope lashings and steel straps. Centered in the deck is a 50-inch-square aperture for the observation chamber.

The chamber is fabricated of 3/16-inch steel, galvanized inside and outside and finished with black asphalt paint. It is 9.5 feet long, has a minimum diameter of 28 inches, and extends below the raft to a depth of 6.0 feet beneath the water surface. Four legs, strengthened with gussets and welded to the chamber, are bolted to four 5/8-inch galvanized steel studs in the timbers around the deck aperture. When bolted in position, the chamber projects 3 feet above the deck.

The 1/4-inch-thick Plexiglas[3/] observation windows are set in polysulphide rubber-base cement and bolted to the window frames; large washers separate the bolt heads and the Plexiglas. The upper six windows are centered 6 inches below the water surface. (Prior to modification these were the only windows in the chamber.) Below the upper windows a hexagonal steel flange, which increases the diameter of the chamber to 47 inches, is welded perpendicular to the cylinder. The frames of the six middle windows, facing horizontally, and of the six lower windows, which are inclined at a 35° angle, are welded to the periphery of the flange and to the cylindrical lower section of the chamber. Three 2-inch pipes that extend from the inside edge of the flange down to the lower section of the cylinder provide additional stiffening.

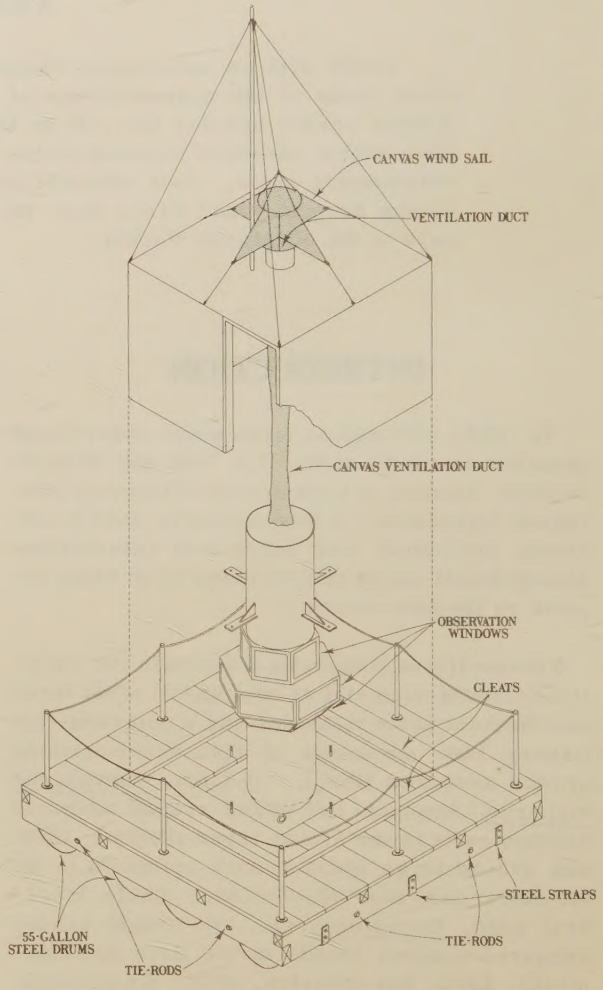


Figure 2.--Plan of the Nenue.

2/ After test drifts near the island of Hawaii several modifications were made. Originally only six 55-gallon drums were used. Four additional drums increased the freeboard and kept the deck drier.

3/ Trade name referred to in this publication does not imply endorsement of commercial product.

The chamber has room for a single observer (fig. 3), who descends into it by a Jacob's ladder. He stands while looking through the upper windows or sits on a revolving stool while using the 12 lower windows. The 18 windows allow an uninterrupted view of the space between the drums and timbers beneath the deck and of the surrounding water. The downward view is obstructed only in the small conical area from the bottom of the chamber to the apex about 12 feet directly below.

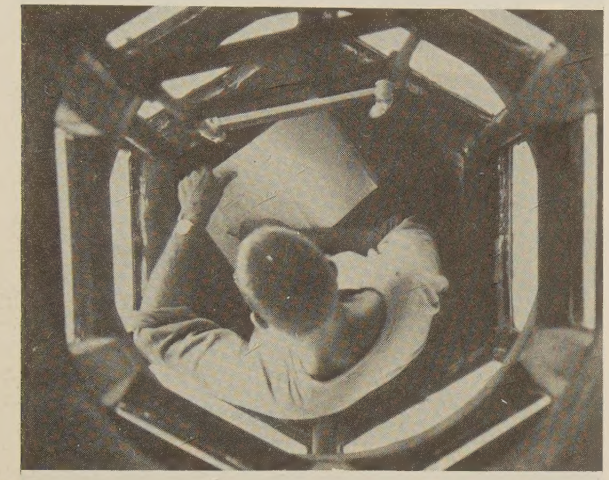


Figure 3.--Looking into the chamber from deck.

The deckhouse is made of 3/8-inch plywood. At its base, four cleats on the deck prevent lateral movement of the deckhouse. Lashings from eyebolts on the side of the deckhouse to those on the deck prevent the house from slipping out of the cleats. Inside the house a gear locker runs the full length of one wall; on the opposite side is a shelf for batteries and radio. A portable watertight metal locker provides protection for such equipment as cameras, binoculars, books, and film. On the roof are mounted the radio antenna and a 12-foot mast equipped with two 360° riding lights. After the first series of drifts, a canvas wind sail was placed on the roof to provide ventilation to the chamber via a canvas duct.

The weight of the Nenue is about 3,500 pounds. The approximate weights of the separate units are: raft, 2,200 pounds; chamber, 1,000 pounds; and deckhouse, 300 pounds. Positive buoyancy of about 7,700 pounds gives it about 12 inches of freeboard when fully loaded.

The Nenue is well provided with emergency equipment. A 33-watt, 5-channel transistorized radio transceiver provides voice communication with the Charles H. Gilbert; it has sufficient power for longer range emergency use. Also on the raft are a radio beacon which, when placed in the water, automatically transmits a signal on the international distress frequency, 2182 kc., and flashes a light visible 50 miles from the air, a radar target mounted on a 12-foot bamboo pole lashed to a stanchion, a two-man CO_2-inflated liferaft, lifejackets, lifering, flare gun, magnetic compass, emergency rations and water, and first-aid supplies. Other equipment includes storage batteries, a parachute, and a skiff. The radio and two masthead riding lights are powered by the 12-volt storage battery; a second battery is kept aboard in reserve. The 28-foot parachute serves as a drogue to reduce wind drift. The skiff, powered by an outboard motor, provides transportation between the raft and the mother vessel. It is moored to the raft when observers are aboard.

HANDLING PROCEDURE

The raft, chamber, and deckhouse are transported on the deck of the Gilbert to the launching area. The raft and chamber are lifted from the deck with the cargo boom, swung outboard, and held clear of the water while the chamber is lowered through the aperture in the raft and bolted into position (fig. 4). During this operation, preventer tackles control any hazardous swinging caused by the ship's motion. After the raft is launched, the house is lowered into posi-

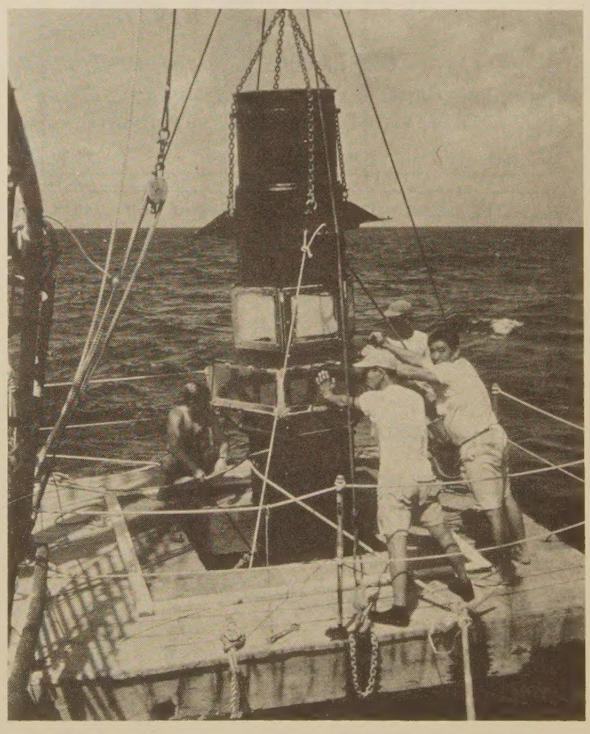


Figure 4.--Raft and chamber swung overside prior to launching.

tion and secured. Next, equipment and supplies are loaded and the raft is set adrift. The procedure is reversed when the raft is taken aboard.

While the raft is adrift, it is manned by two biologists who make continuous observations from dawn to dusk. Watch positions are rotated once each hour; one observer is always in the chamber and one on deck. At night they return to the mother ship, which remains 1/2 to 3 miles away.

EVALUATION

The Nenue proved to be a seaworthy observation platform during five short drifts of up to 2 days off the island of Hawaii in 1962 and during two longer drifts, 8 and 9 days, near the Equator in 1964 (fig. 5). Its major disadvantages lay in

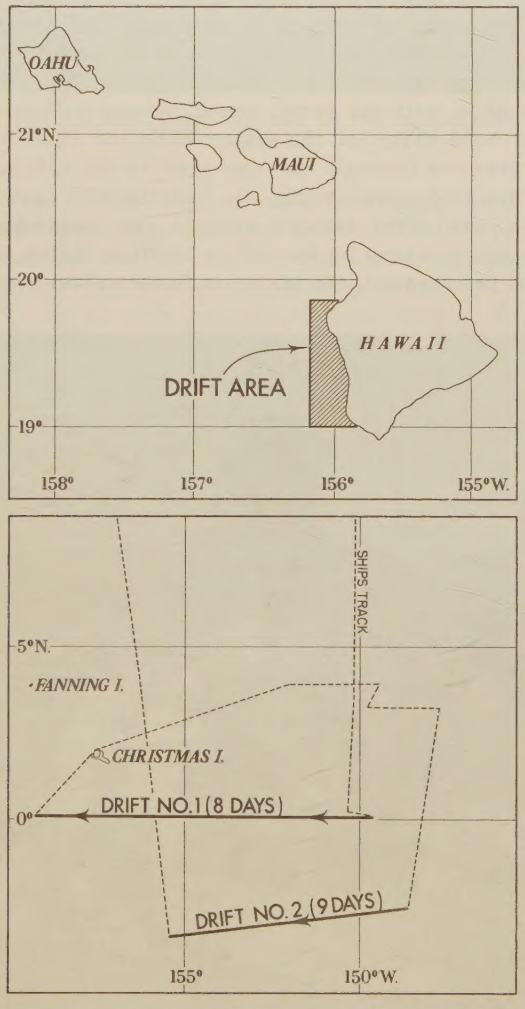
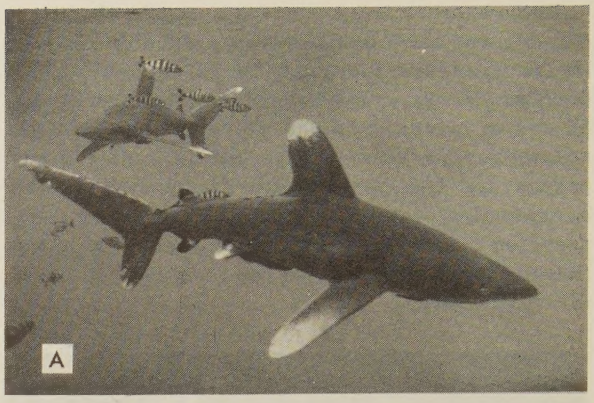
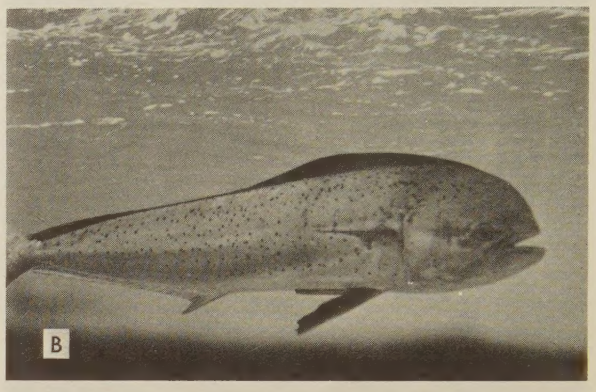
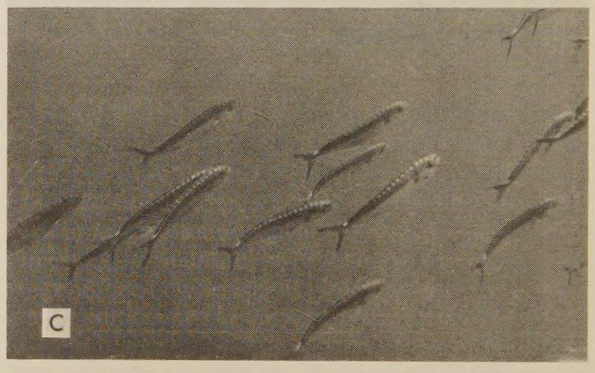


Figure 5.--(Upper panel) drift area southwest of Hawaii; (lower panel) drift tracks of Nenue in the equatorial Pacific.







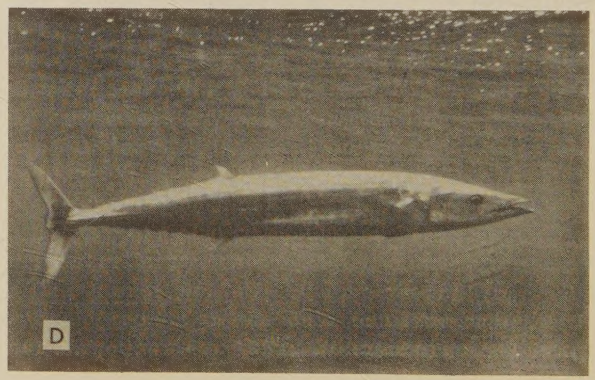


Figure 6.--(A) Whitetip shark, Carcharhinus longimanus, with pilotfish, Naucrates ductor; (B) dolphin, Coryphaena hippurus; (C) 12-15 cm. juvenile Coryphaena sp.; (D) wahoo, Acanthocybium solandri.

the hazards of launching and retrieval and in the discomfort suffered by observers. The launching process, although it has been conducted in seas up to 6 feet, would not be safe or practical with present methods in higher seas or under choppy conditions. The raft has a violent and uncomfortable motion which in seas greater than 3 feet may distract the observers. The Nenue is as large a raft as the Gilbert can handle; however, a larger and more stable raft providing more working space and comfort would be advantageous. Viewing from the chamber could be improved somewhat if the lower six windows were inclined at 45° rather than 35° to permit a better view of the space immediately below the chamber.

Operations with the Nenue have proved her to be seaworthy and effective for the study of accumulations of fishes around a floating object in the open ocean. The fishes nearby could be clearly seen and photographed, and close observations of their reactions toward one another and to the raft were possible. The species present and some of the major aspects of their behavior were reported by Gooding (1964) in a preliminary report on the Hawaiian drifts. The photographs of figure 6 demonstrate the close approach of the fishes and the clarity of observation. They are from a series taken from the chamber during the equatorial drifts.

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